

Spermatogenesis

sperma - sperm (male gamete)

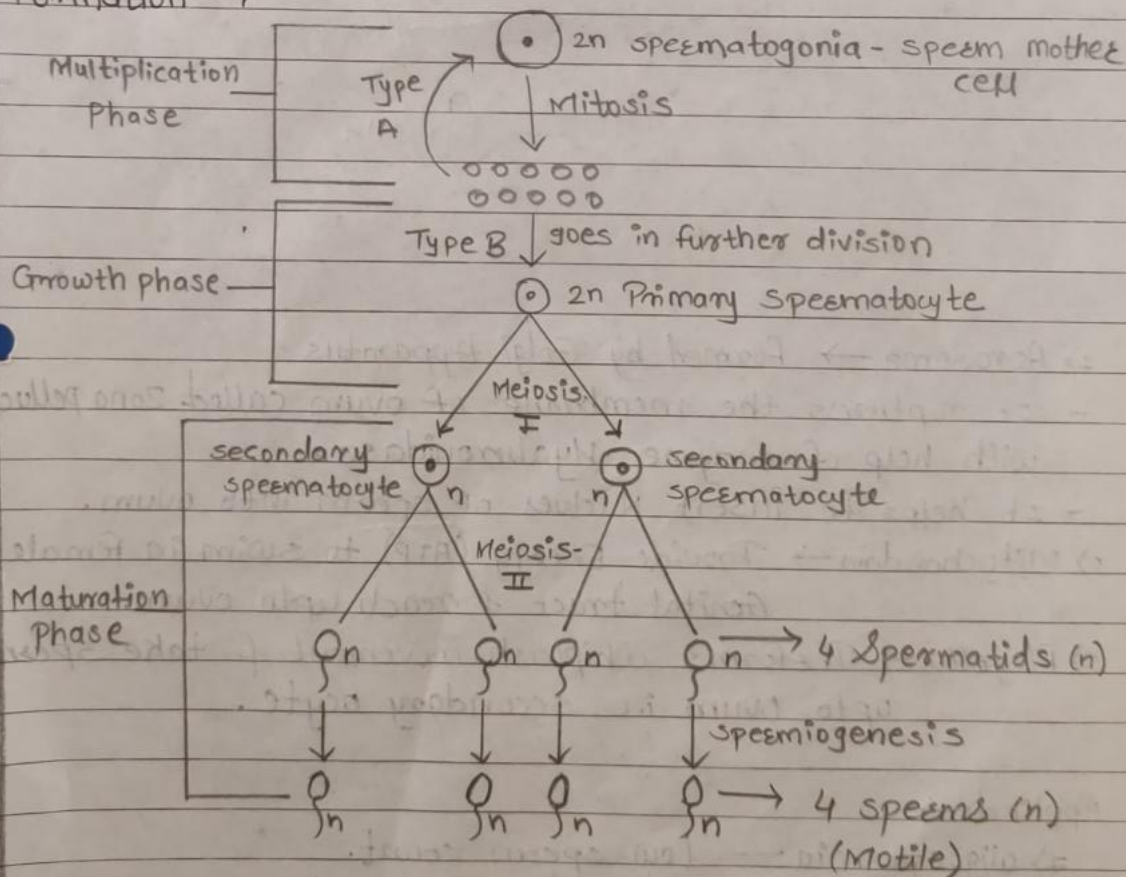
genesis - synthesis / formation

Defination → Synthesis of male gamete i.e. sperm from spermatogonium is known as spermatogenesis.

Introduction →

- 1) starts at Puberty & Production remain life long, but in old age the count of sperms become low.
- 2) Sperms get Produced in seminiferous tubules of testis.
- 3) Daily Production of sperm is 200 Million.
- 4) 40-100 Million sperm /ml of semen but out of which 40% are not motile.

Formation →



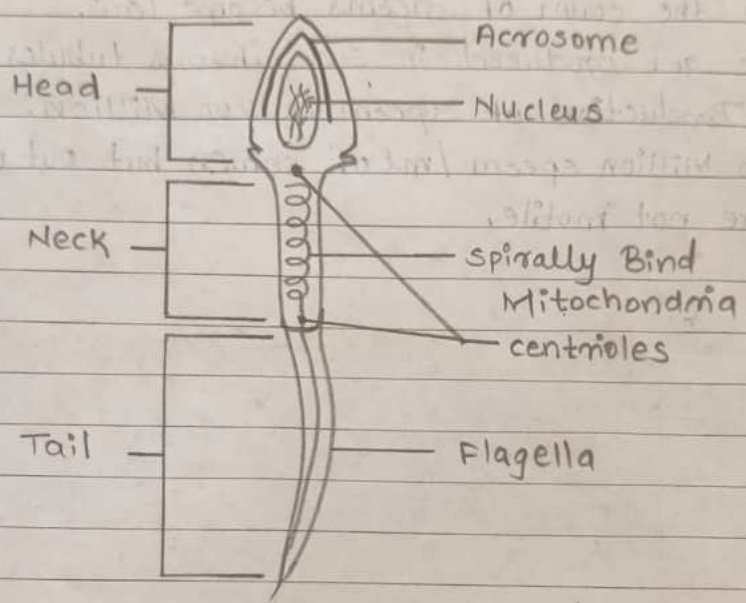
1) Type A → When Spermatogonia (SMC) get divided by mitosis but again restore in form of spermatogonia rather than by going in further divisions.

- 2) Type B → spermatogonia divide by Mitosis & goes in further division (sequential) to form Sperms.
- 3) Hormones like Follicle stimulating Hormone (FSH) & Testosterone are helps in spermatogenesis.

spermiogenesis → Formation of Sperms from spermatids.

spermiation → Removal of Sperms from Sertoli cell (Nurse cell) & get free in flow of semen.

Sperm:



- 1) Acrosome → Formed by Golgi Apparatus
 - It ruptures the membrane of ovum called Zona pellucida with help of enzyme Hyaluronidase.
 - It helps to insert Nucleus of sperm into ovum.
- 2) Mitochondria → Provide Energy (ATP) to swim in female Genital tract & reach upto ovum.
- 3) Flagella → Performs whiplash movement & take sperm upto Ovum i.e. Secondary oocyte.

Applied →

- 1) oligospermia — Low sperm count.
- 2) Azospermia — No sperm formation.
- 3) Infertility — Due to Non-motile Sperms.

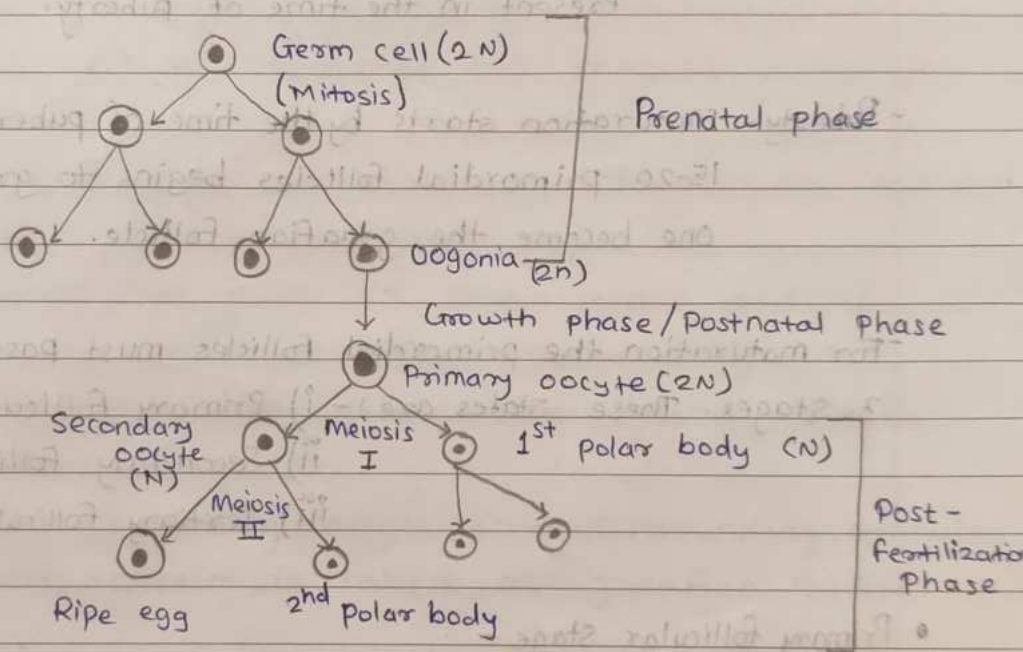
Oogenesis

Def:-

Oogenesis is a process of formation of mature haploid ovum [23] from the diploid oogonia [46].

It has 3 phases :-

- i) Prenatal phase - before birth [formation of primary oocyte]
- ii) Postnatal phase - after birth [Maturation of oocyte]
- iii) Post fertilization phase - after fertilization [Formation of ovum]



i) Prenatal phase -

- Oogenesis starts well before birth.
- By 7th week of intrauterine life the primordial germ cells (46) present in the gonads differentiate into oogonia [46] in the genetically female embryo.
- They increase in number by mitotic division.
- By third month of oogonia arranged into groups and surrounded by flat follicular cells called **oogonial clusters**.

- For the next few months the oogonia increases in numbers by mitosis and by 5th month the number reaches to 7 million.

ii)

Postnatal Phase -

- * Infancy - around 6 lakhs to 8 lakhs primary oocyte are present in the ovary
- * Childhood - most of the oocyte become atretic [2nd cycle of cell death] and approximately 40,000 are present in the time of puberty.
- Puberty - Maturation starts by the time of puberty, around 15-20 primordial follicles begins to grow and only one become the graafian follicle.
- For maturation the primordial follicles must pass through 3 stages. These states are -
 - i) Primary follicular stage
 - ii) Secondary follicular stage
 - iii) Tertiary follicular stage

• Primary follicular stage -

- The following changes occurs in this stage -

i) The flat follicular cells changes into cuboidal cells called the

ii) granulosa cells.

The granulosa cells secretes a glycoprotein layer over a primary oocyte called zona pellucida.

iii) Now the granulosa cells with a primary oocyte is called primary follicle and primary oocyte is still in the prophase I of meiosis I.

- Secondary follicular stage -

- The following changes occurs in this stage -

- i) The granulosa layer increases in number up to 9 layers called as stratum granulosum.

ii) The surrounding ovarian stroma will be differentiated into outer fibrous theca externa and inner secretory theca interna.

- Tertiary Follicular stage:-

The following events occurs in this stage -

- i) Meiosis I will be completed two unequal daughter cells forms.

ii) The large daughter cell with 23 chromosomes and all cytoplasm is called secondary oocyte.

iii) The smaller one with 23 chromosomes and no

cytoplasm is called as first polar body.

- iv) The secondary oocyte enters into second meiotic division.

v) The large secondary oocyte with surrounding granulosa cells and antrum is called as graafian follicle.

iii) Post Fertilization Phase -

- During ovulation the secondary oocyte with the surrounding corona radiata will be released and reach the ampulla of fallopian tube.

- Meiosis II will be completed and two more polar bodies will form only if the oocyte is fertilized otherwise the secondary oocyte degenerates approximately 24 hours after ovulation.

So from one diploid primary oocyte [46], one haploid mature ovum (23) and 3 haploid polar bodies (23) will form.

Applied -

- 1) Female infertility
- 2) Abnormal menstrual cycle
- 3) Ovarian cyst

FERTILIZATION

1) Definition: It consists of sequence of events that begins with contact of sperm with secondary oocyte and ends with fusion of their pronuclei to form zygote.

2) Prerequisites:-

a) Capacitation of sperms: It involves removal of glycoprotein coat and from the surface of acrosome. It is done by secretions from uterus and uterine tube.

b) Acrosome reaction: It involves ^(release) liberation of enzymes from the acrosome with development of multiple ^(hole) perforations in the outer coat of acrosome.

3) Time:- The process of fertilization lasts for about 24 hours.

4) Site of fertilization: Ampulla of fallopian tube/uterine tube.

5) Stages of fertilization:

i] Sperm passes through corona radiata. This is helped by hyaluronidase, an enzyme released during acrosomal reaction.

ii] Sperm passes through zona pellucida with the help of acrosin and neuraminidase action.

iii] Zona reaction: Once the first sperm enters the oocyte crossing zona pellucida, the remaining zona pellucida

undergoes a physicochemical change, which renders it impermeable to the entry of sperme, this is called as zona reaction. It occurs due to the substance released by cortical granules in the cytoplasm of secondary oocyte.

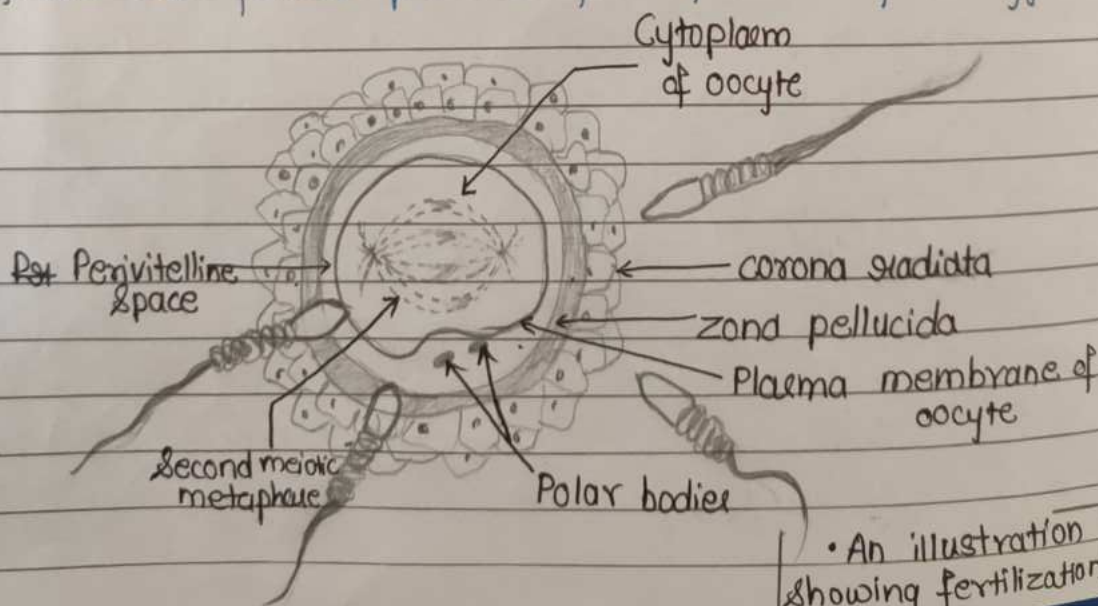
iv] Sperm attaches to the surface of the secondary oocyte. Their plasma membranes fuse, break and the (disappear).

v] The sperm head (nuclear material) and tail enter the oocyte. Plasma membrane of the sperm remains outside.

vi] Secondary oocyte completes its second meiotic division, expels second polar body, and its nucleus now forms female pronucleus.

vii] Within ooplasm (cytoplasm of oocyte) the sperm tail degenerates and its head forms male pronucleus.

viii] Male and female pronuclei ~~form~~ fuse to form zygote.





6) Results of fertilization:

a. Reconstitution of diploid/species-specific chromosome number, that is, 46 in human being.

b. Species variation due to biparental inheritance.

c. Chromosomal sex of the baby is determined at the time of fertilization depending on whether it is 'X' or 'Y' bearing sperm that fertilizes oocyte - Sex determination

d. Initiation of cleavage.

7) Applied:

a. In vitro fertilization - Test tube baby.

b. Dispermy - If the zona pellucida reaction is not prompt, then two sperms may enter the oocyte, resulting in triploidy (60 chromosomes). Usually it ends in abortion or genetically abnormal baby.

IMPLANTATION

• Definition →

Implantation of blastocyst inside the endometrium/Decidua of the uterus.

• Normal site of implantation →

Uterus has 2 parts

- i) Upper uterine segment, i.e. Fundus + upper of body.
- ii) Lower uterine segment, i.e. lower of body + cervix.

So, the normal site of implantation is posterior wall of upper uterine segment.

• Pre-implantation event →

- After fertilization zygote undergoes series of mitotic division & forms 2 celled stage, 3 celled stage upto 16 celled stage.
- This embryo look like mulberry fruit & is called as Morula.
- After next division it is called as Blastula which consist of cavity called Blastocoel.
- Upto here it is cover by zona pellucida which prevent the attachment of this into uterine i.e. is implantation.

• Stages of implantation →

- i) Hatching
- ii) Apposition
- iii) Adhesion
- iv) Invasion

i) Hatching →

The blastocyst is still enclosed in the egg coat known as the zona pellucida, & for it to be able to implant into the uterine wall it must be rid of itself of this covering. This stage is known as Hatching.

ii) Apposition →

- The very first loose connection or contact between the blastocyst & the endometrium is called apposition.
- Apposition is usually made where there is small crypt in the endometrium.

iii) Adhesion →

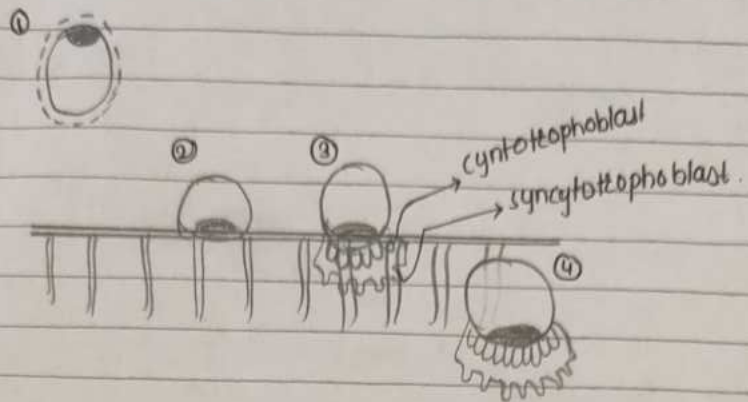
Adhesion is much stronger attachment to the endometrium than the loose apposition.

iv) Invasion →

- The process of implantation allows fetal trophoblast cells to invade & migrate into the decidua.

* When the placenta forms the hormone is secreted namely, Human chorionic gonadotropin hormone [hCG].

• Diagram →



• Applied Anatomy →

i) Tubal pregnancy :

- Also, known as Ectopic pregnancy.
- The zona pellucida disappear early, the egg implants somewhere other than the uterus often in the fallopian tube.
- This is why ectopic pregnancies are commonly known as 'Tubal pregnancy'.
- The egg also can implant in the ovary or the cervix.

ii) Placenta Previa :

- In this zona pellucida disappear late.
- Implantation of placenta partially or completely in lower uterine segment. So, placenta comes out first at the time of delivery.
- This is type of APH [Antepartum Haemorrhage].

iii) Urine pregnancy test (UPT) :

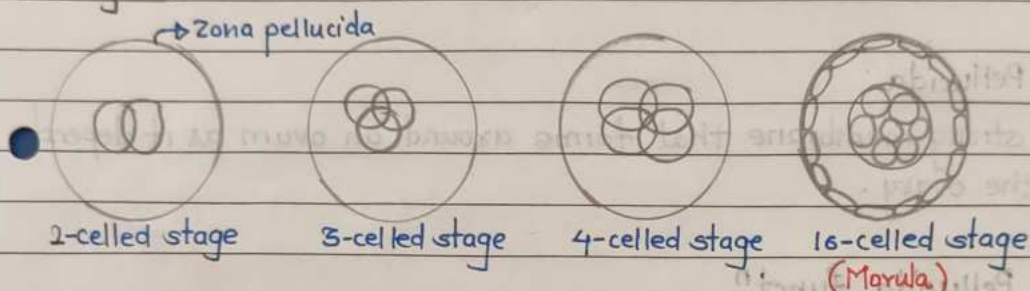
During pregnancy placenta secrete HCG, which is secreted in urine to confirm pregnancy.
HCG urine is tested after 40 days of absence of menses.

CLEAVAGE - The process of cell division after fertilization.

• Intro -

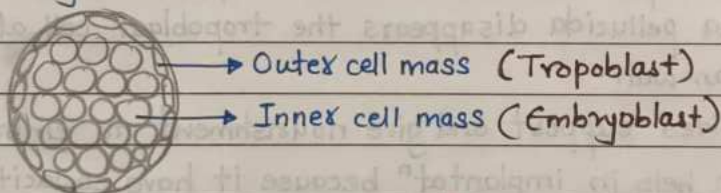
- Series of division takes place in zygote to form embryo.
- It is mitotic division.
- Zygote is 100um in diameter and it is largest cell in human body.
- Duplicatⁿ of chromosome takes place in that division.

• Stages -



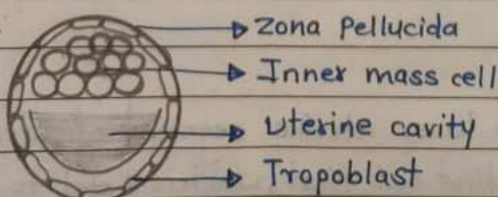
1. Zygote 1 celled is divided into 2-celled stage then 3-celled stage upto 16-celled stage.
2. 16 celled stages occurs.
3. 16 celled stage called as "Morula".

Morula -



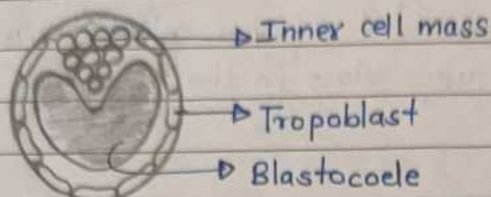
4. Morula has covering called **Zona Pellucida**.
5. Inner cell of morula called **Inner cell mass** and they form embryo that is **Embryoblast**.
6. Outer cell of morula called **Outer cell mass** and they form embryo that is **Tropoblast**.
7. Morula present in upper part of uterus and food obtained from uterine cavity and tropoblast cell.
8. When uterine fluid inter into morula and formation of cavity takes place then the cell is called as **Blastula** (32-celled stage).

Blastula -



3. Uterine fluid push inner cell mass towards upper side of blastula and cavity become larger hence it is known as **Blastocyst** and cavity known as **Blastocoele**.

Blastocyst



• Zona Pellucida

- The strong membrane that forms around an ovum as it develops in the ovary.

• Zona Pellucida functⁿ

1. Zona pellucida prevents the attachment of embryo at abnormal site i.e. (**ectopic pregnancy avoid**)
2. When blastocyst is formed then zona pellucida disappears.
3. When zona pellucida disappears the trophoblast cell attached to the uterine wall.
4. Wall provides support and give nourishment to embryo.
5. Trophoblast help in implantatⁿ because it have capacity to attach the embryo.

• Applied

1) Tubal Pregnancy

- The zona pellucida disappear early, the egg implant somewhere other than the uterus often in the fallopian tube.
- This is why ectopic pregnancies are commonly known as Tubal pregnancy.

2) Placenta Previa

- Implantatⁿ takes place in lower uterine segment of uterus. During pregnancy, placenta comes first out first, which is fatal to death.
Delivery

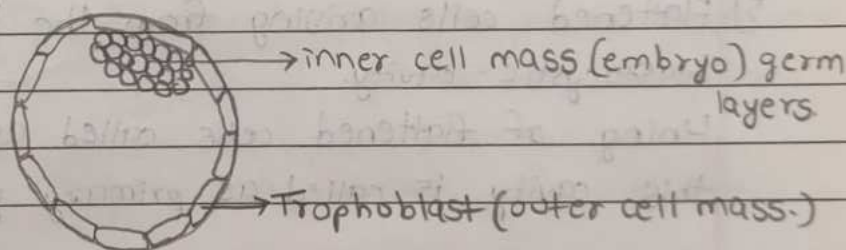
Bilaminar Disc Formation

* Introduction →

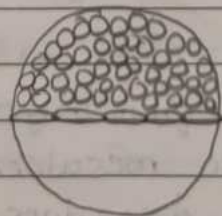
- a) The embryoblast / inner cell mass becomes bilaminar embryonic disc and comprises of an epiblast and hypoblast.
- b) Trophoblast differentiates into an inner cytotrophoblast and outer syncytiotrophoblast.
- c) Two cavities develop →
 - An amniotic cavity along the epiblastic face,
 - The yolk sac on the hypoblastic side.
- d) During the 2nd week the process of implantation completes.

* Events in 2nd week →

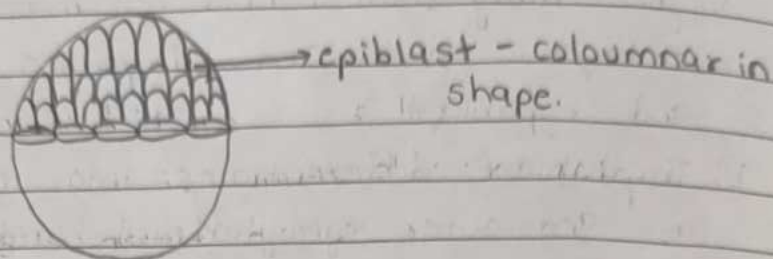
- 1) Blastocyst is a spherical cyst lined by trophoblastic cells and that inside it there is a mass of cells, the inner cell mass attached eccentrically to the trophoblast.



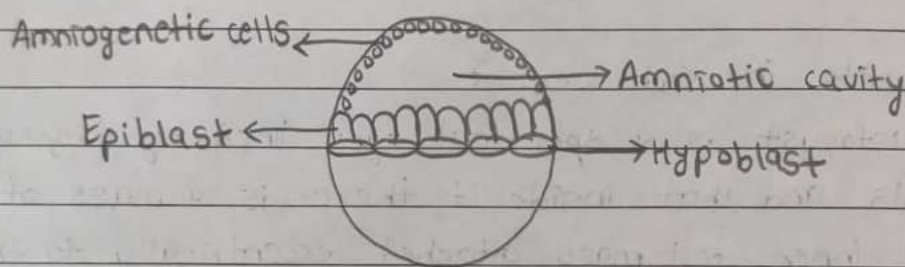
- 2) Some cells of the inner cell mass differentiate into flattened cells, that come to line its free surface this layer called as hypoblast.



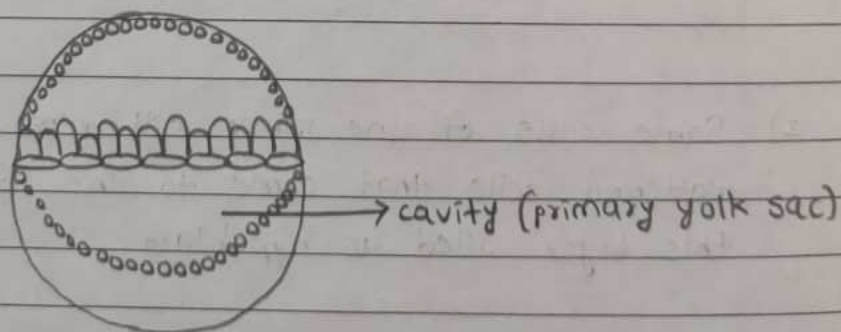
- 3] The remaining cells of the inner cell mass become columnar form the epiblast.



- 4] A space appears between the epiblast and trophoblast. This is the amniotic cavity filled by amniotic fluid. The roof of this cavity is formed by amniogenic cells.

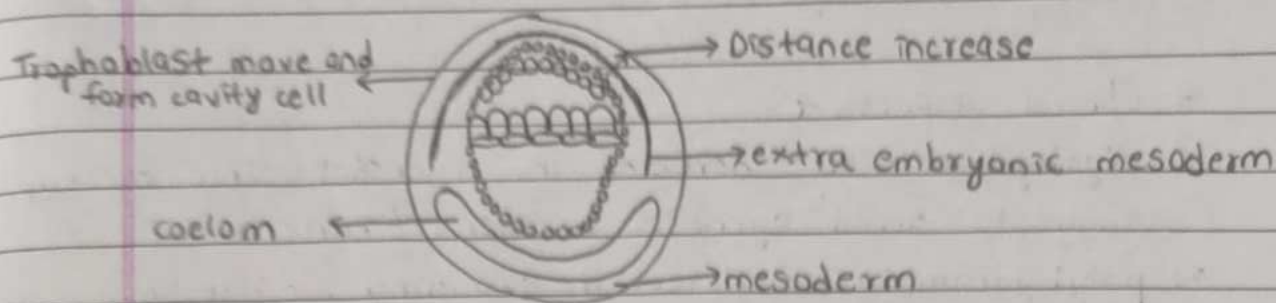


- 5] Flattened cells arising from the hypoblast lining the blastocystic cavity. Lining of flattened cells called as Heuser's membrane, this cavity is called as primary yolk sac.



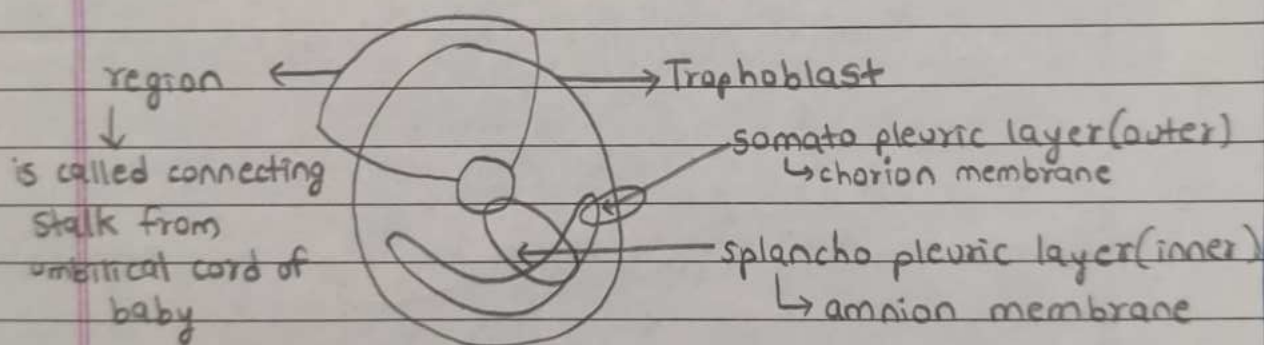
- 6] The cells of trophoblast give origin to mass of cells called as extra embryonic mesoderm because it lies outside the embryonic disc does not give any

rise to tissues of embryo.



7) Then one large cavity is formed called as extra embryonic coelom.

wall of blastocyst and the extra embryonic mesoderm forms structure called as connecting stalk. Because of coelom mesoderm divides into two layers inner or (outer - parietal layer = somato pleuric layer)



* Significance of Amnion and ~~chorion~~ yolk sac are as follows :-

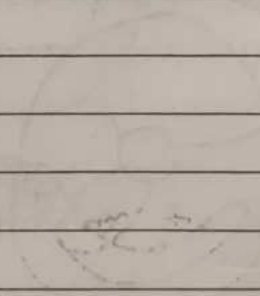
- 1) Amniotic fluid provides buoyant medium permitting symmetrical growth of the embryo.
- 2) protects the embryo against injuries received by mother on abdomen.
- 3) Thermoregulation of the fetal body temperature.
- 4) During 2nd - 3rd week - transfer of nutrients before uteroplacental circulation.
- 5) During 4th week - forms foregut, midgut, hindgut.

6) Haemopoietic activity

7) Allantois develops.

* Clinical aspects →

- 1) oligohydramnios - detected in antenatal clinic checkup suggests renal agenesis unilateral / bilateral.
- 2) polyhydramnios - defect in swallowing mechanism.
- 3) Amniocentesis - prenatal diagnostic procedure.
- 4) Meckel's diverticulum



Gastrulation

Definition

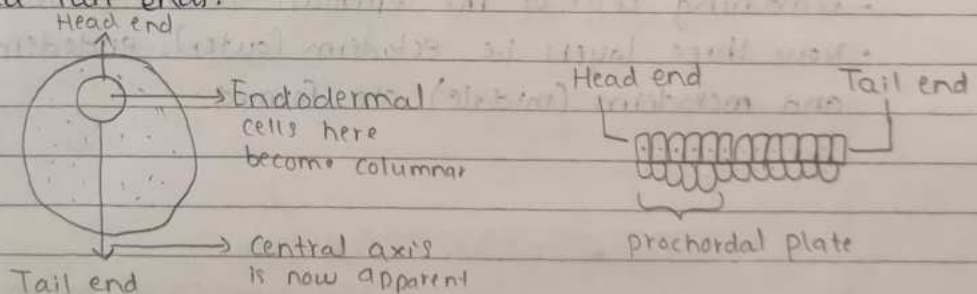
- The process of formation of the primitive streak of endoderm and of the intraembryonic mesoderm (by the streak) is referred to as gastrulation.

Changes

- 1) Prochordal plate
- 2) Primitive streak
- 3) Three germ layer formation.

1) Prochordal plate

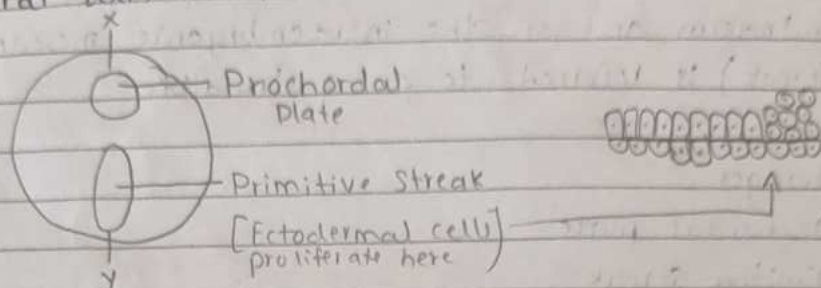
- At one circular near the margin of the disc, the cubical cells of the endoderm become columnar. This area is called the prochordal plate.
- The appearance of the prochordal plate determines the central axis of the embryo i.e. allows us to divide it into right and left halves.
- It also allows us to distinguish its future head and tail ends.



2) Primitive streak.

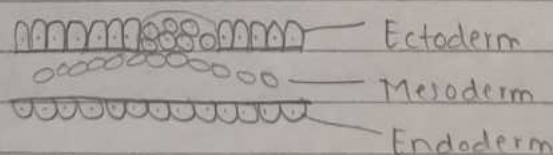
- Soon after the formation of the prochordal plate, some of the epiblast cells lying along the central axis, near the tail end, of the disc, begin to proliferate and form an elevation that bulge into the amniotic cavity. This elevation is called the primitive streak.

- The primitive streak is at first a rounded or oval swelling, but with elongation of the embryonic disc it becomes a linear structure lying in the central axis of the disc.



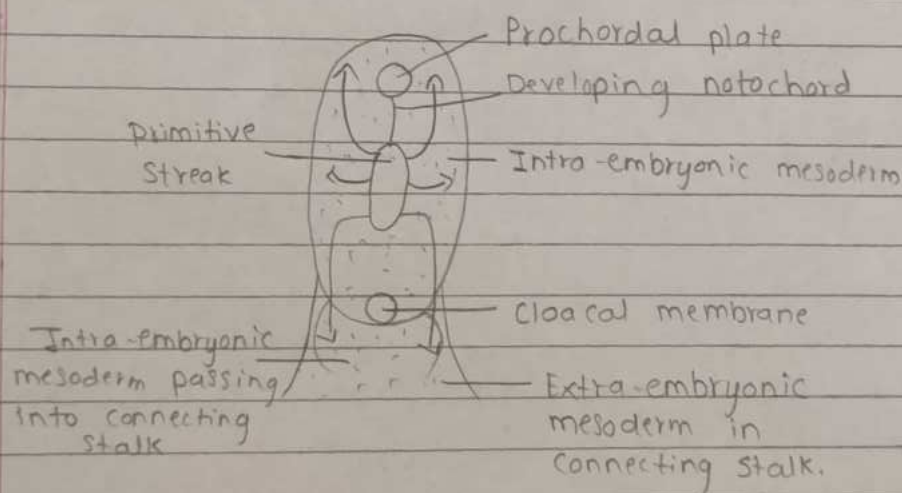
3) Three germ layer formation

- The cells that proliferate in the region of the primitive streak pass sideways, pushing themselves between the epiblast and hypoblast.
- These cells form intra-embryonic mesoderm / 2^o mesoderm.
- Some cells arising from the primitive streak displace the hypoblast and form the layer known as endoderm.
- Both endoderm and mesoderm are derived from epiblast.
- Remaining cells of the epiblast forms ectoderm.
- Now three layers i.e. ectoderm (outer), endoderm (inner) and mesoderm (middle) are formed.



- The intra-embryonic mesoderm spreads throughout the disc except in the region of the prochordal plate. This region remains relatively thin and later forms the bucco-pharyngeal membrane.
- The primitive streak gradually elongates along the central axis of the embryonic disc. Disc also elongates.

- The embryonic disc is 1st formed & suspended from the trophoblast by connecting stalk, which is very broad as compared to embryo.
- As embryonic disc elongates, connecting stalk becomes small, & attaches to the tail end of the embryonic disc.
- Some intraembryonic mesoderm arising from the primitive streak passes backwards into the connecting stalk.
- During this, it leaves an area caudal to primitive streak, where ectoderm and endoderm remain in contact.
- This region is, therefore similar to the prochordal plate, & forms the cloacal membrane.



Applied Anatomy

- Stem cell therapy:-

- The stem cells can be maintained and propagated in an undifferentiated state, in culture, in laboratories.
- Stem cell can form various types of adult cells eg. neurons, muscle cells, blood cells & cartilage cells
- Stem cells are also called pluripotent.